ENVIRONMENTAL STUDY OF ERTS-1 IMAGERY

LAKE CHAMPLAIN BASIN AND VERMONT

Proposal No: SR 347
GSFC ID No: UN 137
Contract No: NAS 5-21753

PRINCIPAL INVESTIGATOR: Dr. A. O. Lind

Type II Progress Report
(June - November)

1 December 1972

PROGRESS REPORT

(June - November 1972)

Problem Areas

In the early stages of the study (August), positive prints were cut from the Product Order Form without prior consultation with the principal investigator. Positive 9 inch format prints have been back-ordered to cover the period of non-delivery of positive prints and ordered for future coverages. These prints were found to be particularly useful for preliminary analysis by co-investigators and have also been useful for briefing of state and local officials since this product is easily transportable and does not require specialized viewing equipment. Besides being easy to use, the prints are not readily damaged as might be the case with transparencies. No back ordered prints have yet been received. Although the negatives provided could be used to generate prints, negative quality is such that our local photo laboratory has had little success in generating prints.

Accomplishments

The study is currently in the concluding stages of Phase II (Preliminary Data Analysis) and four of the six objectives originally proposed have been found to be feasible. Objective e), p I-4 of the original proposal was

not found to be feasible. This objective was to attempt an examination of lake surface roughness in relation to wind direction and velocity. The magnitude of wave action on Lake Champlain is apparently too small to be detected. Objective e) is an attempt to document lake level changes. A determination of feasibility has been hindered by an unusually high lake-level pattern during the period of ERTS coverage. Additional time will be required to assess the feasibility and accuracy of any technique which is developed to allow fluctuations to occur.

As a result of Phase II investigations, two additional objectives are proposed, one of which has already been determined as feasible, while the other is suspected as being highly feasible. These are, in the same order:

a) Map and interpret pollutant discharges into Lake Champlain from major sources including industrial and urban.

b) Map and interpret the pattern of lake ice development during the winter and attempt detection of thermal properties by using ice/water pattern relationships.

The objectives which have been documented by preliminary observations include:

a) Identification and mapping of major land use categories. A first-approximation land-type map of the Burlington study area was produced.

Further subdivisions will be investigated and cropland use will require accuracy of interpretation determinations due to omission errors which occur from the generally small field sizes prevalent in the study area.

b) Identification of surficial deposits and associated landforms. A number of different categories remain to be recognized, but early indications are that most will be located.

c) Identification and mapping of aquatic communities (algae, shore-vegetation and wetlands). Algal blooms and wetlands were delineated on early coverage.

d) Identification and mapping of lake turbidity. A major turbidity boundary was located and positions of this boundary will be monitored. Turbidity patterns in river mouth areas were also detected, but problems related to shallow water bottom reflectance, has thus far prevented their actual delineation due to the confusion of the two patterns (bottom topography and turbidity).

e) Identification, interpretation and delineation of lake pollution inputs. A major plume related to industrial activity was discovered, and additional ones are expected to appear with further close study.

The University of Vermont remote sensing laboratory, which provides a central location for image analysis, has most items of equipment needed to complete the investigation. The multispectral viewer received near the end of the last bimonthly reporting period has been used for image enhancements on an experimental basis. Procedures are being evaluated for the application of the equipment to specific objectives.

A rapid, simple, and useful technique for mapping directly on overlays over positive enlargements derived from 9 inch positive transparencies was developed using Polaroid MP-3 copy camera equipment. The technique also provides a certain measure of image enhancement, but its particular value is the enlargement capability and resulting image of suitable quality for many mapping purposes. Scale standardization will be attempted using the Polaroid equipment.

Significant Results

a) Land-use mapping. A land-use map derived for the Burlington area is particularly relevant to current activity regarding a state-wide land-use plan currently being submitted for discussion by local communities. The information pertaining to land-use will require periodic updating and it appears that ERTS data will provide a basis for evaluating land-use changes of major proportions, such as monitoring the urban sprawl phenomena, and the general trend of rural land-use change from agricultural to residential.

b) Limnology. Among the significant results in this discipline area, the recognition of 1) major turbidity zones and boundaries, 2) algal blooms and 3) pollution plumes are the more important because they relate directly to water quality. These features have been identified on ERTS-1 imagery and this information has several applications in the monitoring of lake conditions for general resource management purposes. It is expected that monitoring of ice conditions this winter will contribute additional information regarding such matters as the nature of lake freeze which is important to early spring and early winter navigation on the lake.

Most of the information regarding the lake has to do with understanding its basic limnology. While much progress has been made, a number of aspects yet remain to be explained.

Cooperation with other nearby limnological investigators has been initiated, and through this means, it is anticipated that further discoveries will be forthcoming.

Monitoring of pollution plumes is currently an item of major interest to the State of Vermont and the information from ERTS may figure significantly in resource management decisions currently in progress.

c) Wetlands. The delineation of wetlands was accomplished for several important tracts adjacent to Lake Champlain as well as for minor floodplain tracts. Wetlands are one of the most important land-types in the land-use planning activity of the State. While the inventory of wetlands is nearly complete, information relating to changes within wetlands and in surrounding areas is particularly valuable in the assessment of wetland ecology. Classification of the wetlands is in progress, and information from ERTS-1, may aid in this task. Recognition problems relating to marginal wetlands exist, but analysis of additional seasonal data may make such recognition possible.

e) Geomorphic and Landform Surveys. Major ice-marginal and lacustrian features were identified and other features are expected to emerge in the continuing analysis phase. As in many areas affected by continental glaciation, any interpretation relating to ground water relies strongly on geomorphic evidence. Therefore, it is particularly important to first identify major landform features related to glaciation, including the extent of former inland seas and lakes. Geomorphic information generated thus far has significance from an environmental point-of-view in that ground water interpretation which will follow can be related directly to other changes affecting ground water, as for example in the rapidly developing rural areas where residential land-uses are encroaching upon recharge zones.

f) River Monitoring. While major rivers can be readily detected and floodplain areas approximately located, no significant changes have been noted primarily due to above normal precipitation which has kept flows from ranging considerably. Although this is not an objective of this study, it is so closely related to the limnological phases of this study that it is included, and it is expected that changes may be noted during the course of the investigation.

Cost-Benefit Estimates

A firm basis for estimating cost-benefit ratios has not yet been devised for all the types of information included within the scope of this investigation. A crude cost-benefit estimate for land-use mapping was derived by comparing total NASA funding for the land-use phase. Comparing this cost to costs of other conventional means of gathering this type of information yields an estimated ratio of 1:2. This ratio should tend to increase as additional images are received since these new images constitute new data.

Progress

(Bimonthly ending December 1)

Preliminary analyses were conducted during this period resulting in the feasibility evaluation of original objectives (see p. 2). One objective was abandoned and one categorized as questionable. First-look analyses were completed and reported.

A number of excellent MSS images were received and have proceeded through early stages of analysis. Most of the information on those images pertinent to this study will be reported in the continuing analysis phase, although a significant result has already been reported using the 10 October coverage of Lake Champlain.

Planned Activity for the Next Reporting Period

This period will focus on continuing analysis in which specific objectives are investigated and reported as significant results.

The seasonal effects now beginning to show on ERTS imagery can be evaluated more fully. The seasonal effects may aid considerably in some problem areas previously identified.

Further development of multispectral viewing techniques will be attempted and current techniques relating to the use of Polaroid MP-3 equipment improved.

Additional ground truth investigations will be minimal due to adverse winter conditions now becoming established.

Work will continue on problem areas identified previously; such as turbidity pattern-bottom differentiation, lake level indicators, and cropland survey.

SUMMARY OF SIGNIFICANT RESULTS BY DISCIPLINE

NASA Category

2. A. Land Use Classification

2. C. Thematic Mapping

A first approximation land-type map using three (3) categories of classification was generated for the Burlington study area. Categories mapped include: 1) Woodland 2) Open land 3) Built-up area. These were mapped directly on direct positive enlargements of 9 inch positive transparencies using first-look RBV band 2 imagery at an approximate scale of 1:143,000.

NASA Category

4. D. Limnology

The identification and mapping of a major turbidity front separating turbid waters of the southern arm of Lake Champlain from the clearer main water mass was reported on RBV band 1 and 2 imagery and appears on subsequent MSS coverage in bands 4 and 5. Lessor turbidity zones associated with river mouth areas were also detected on both RBV and MSS imagery.

Algal blooms (blue-green and diatoms) were identified toward the southern end of the lake on RBV bands 1 and 2.

NASA Category

7. C. Lake Pollution Survey

Significant industrial pollution of Lake Champlain has degraded environmental quality in certain sections of

the lake. A major plume discharge of pollutants was detected on MSS band 4 and 5 imagery. The plume results from underwater discharge of paper mill wastes and is a particularly well-developed feature which can be readily seen with slight magnification.

NASA Category

4. C. Wetlands Surveys

Wetlands were detected and recognized using a combination of RBV bands 2 and 3. Delineation of major wetlands was possible along with some minor wetlands associated with river floodplains (meander scars). The wetlands were first detected from RBV imagery from 30 July, but later MSS imagery showing seasonal effects seems to provide more subject-background contrast for easier delineation.

NASA Category

3. I. Geomorphic and Landform Surveys

Using first-look RBV band 2 imagery, major ice-marginal features were identified by using tonal patterns associated with vegetative cover. Similarly, former shorelines of the Champlain Sea were detected and recognized.

NASA Category

4. K. River Monitoring

Major rivers were detected and recognized through the use of RBV band 3 imagery and later through the use of

MSS bands 6 and 7. While no changes have been clearly identified to this date, it is very likely that seasonal effects now beginning to be displayed will affect the major rivers enough to induce changes in flow and channel pattern. Subsequent analysis of seasonal ERTS-1 imagery may reveal the changes expected.